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Fighting Invasive Forest Pests and Pathogens in West Virginia

This brochure describes 11 of the most invasive forest pest and pathogen species that threaten West Virginia's forest ecosystems, with information about their appearance, history and habitat, the ecological threat they pose, and possible controls and preventative measures that could reduce their impact on the state's forests.



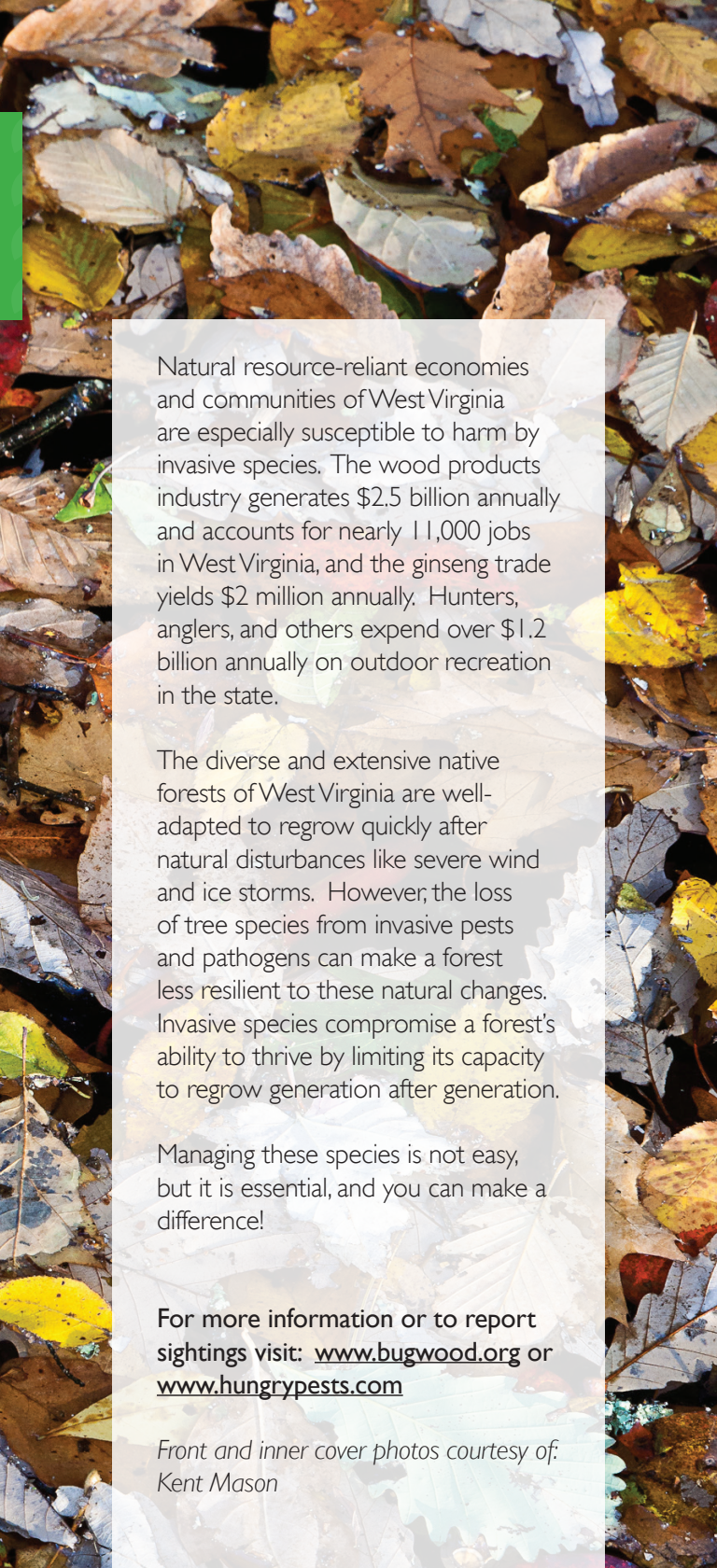


What are Non-native Invasive Forest Pests and Pathogens?

Invasive forest pests and pathogens are insects and diseases that spread at uncontrolled rates when introduced to new areas, damaging and killing large numbers of trees. Because they are outside of their native range, they usually have few natural predators or diseases to keep their populations in check.

In most cases invasive forest pests and pathogens are introduced to the United States accidentally. An intentional introduction was the gypsy moth caterpillar, brought to Massachusetts for silk-spinning. Other invasive species like Asian longhorned beetle, chestnut blight, and hemlock woolly adelgid arrived accidentally, hidden in imported wooden shipping materials or nursery plants. Once arrived, they spread into surrounding natural areas and found the host plants they needed to flourish.

The impact to the nation's environment and economy from invasive species is enormous. In addition to the direct effects on trees and forests, infestations alter wildlife habitats and compromise stream health. Damages in the U.S. have been estimated at over \$138 billion annually from losses in forest products, tourism, and recreation industries.



Natural resource-reliant economies and communities of West Virginia are especially susceptible to harm by invasive species. The wood products industry generates \$2.5 billion annually and accounts for nearly 11,000 jobs in West Virginia, and the ginseng trade yields \$2 million annually. Hunters, anglers, and others expend over \$1.2 billion annually on outdoor recreation in the state.

The diverse and extensive native forests of West Virginia are well-adapted to regrow quickly after natural disturbances like severe wind and ice storms. However, the loss of tree species from invasive pests and pathogens can make a forest less resilient to these natural changes. Invasive species compromise a forest's ability to thrive by limiting its capacity to regrow generation after generation.

Managing these species is not easy, but it is essential, and you can make a difference!

For more information or to report sightings visit: www.bugwood.org or www.hungrypests.com

*Front and inner cover photos courtesy of:
Kent Mason*

Beech Bark Disease

Cryptococcus fagisuga (insect) + *Nectria* spp. (fungus)

Description

Beech bark disease has been a threat to American beech since 1890 when it was accidentally brought to Canada from Europe. It spread south along the Appalachian Mountains and reached West Virginia by 1981.

The disease depends on the interaction between a tiny beech scale insect and a bark decaying *Nectria* fungus. The scale insect infests a tree and feeds just below its thin, smooth bark. Infested tree boles are covered by white wax secreted by the scale insects. As insects multiply, the beech bark weakens. *Nectria* fungal spores, transported by wind or rain, enter the bark through holes and cracks. Cankers develop under the bark and interrupt water and nutrient flows in the tree, which succumbs to the disease over several years.

Species Affected

American beech is the only species impacted by beech bark disease.





Ecological Threat

The American beech is an important tree species for wildlife. Beech nuts are a valuable source of food for deer, squirrels, bears and other mammals. Cavities in older trees are regularly used for dens by mammals and nests for birds. Roots on dying trees send up beech sprouts, but the sprouts never reach tree size. The resulting dense thickets of beech saplings inhibit the growth and development of other plants and trees.

Management

Professional foresters recommend forestry activities that reduce the number of susceptible and infested beech trees. Observations reveal that a very small percentage of beech trees resist beech bark disease attack. Restoration programs identify and take cuttings from resistant beech to propagate seedlings that can be planted in forests to establish American beech trees that are free of disease.

Photo credits

Background: J. O'Brien, USDA-FS, Bugwood.org; Bottom, left to right: L. Haugen, USDA-FS, Bugwood.org J. O'Brien, USDA-FS, Bugwood.org



Sudden Oak Death

Phytophthora ramorum

Description

Sudden oak death is a relatively new disease to North America. In natural areas of California and Oregon it is killing many species of oaks.

Sudden oak death is caused by the pathogen *Phytophthora ramorum*.

The disease enters the bark of the tree and creates cankers on the trunk that eventually girdle the tree. Symptoms include droplets of dark reddish brown liquid, released by the “bleeding” cankers, and dieback of the foliage. As cankers girdle the tree, leaves turn brown and eventually the entire crown dies. Tree death may occur within several months to several years after initial infection.

Species Affected

Based on the oaks it has killed in California, eastern oaks of the red oak group are most susceptible to sudden oak death. Other plants that can be infected but not killed by the disease include Viburnums, huckleberry, beech, mountain laurel, rhododendron, and witch-hazel. The disease relies on such host plants to grow and spread its spores to surrounding oaks.

Photo credits:

All photos: J. O'Brien, USDA-FS, Bugwood.org

Ecological Threat

Oaks dominate many forests in the eastern U.S. and these trees provide food and shelter to numerous wildlife species. Should sudden oak death spread to eastern forests it would devastate oak forests where it takes hold. Infected forests in the western U.S. have seen changes in species diversity, which destabilizes ecosystems and decreases the variety and quantity of wildlife food sources.

Management

The use of WV-grown nursery stock helps reduce the risk of introduction. *P. ramorum* has been detected on a variety of host plants grown in California nurseries. Not yet detected in West Virginia, the continued inspection of incoming nursery shipments and surveys for the pathogen near nurseries are the first lines of defense in stopping accidental introductions.



Chestnut Blight

Cryphonectria parasitica

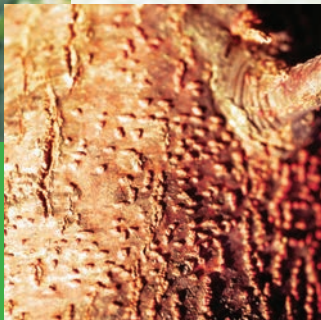
Description

Arriving in the United States in 1904 on imported Asian nursery stock, chestnut blight quickly spread across the entire natural range of the American chestnut, killing 3.5 billion trees. By the 1950's, virtually all mature American chestnuts had succumbed. The tree survives in its native range only as sprouts from old stumps and root systems.

Chestnut blight occurs when the fungus *Cryphonectria parasitica* infects a tree through wounds and cracks in the bark. Sunken or swollen cankers form on twigs, branches and the main stem, killing the inner bark and girdling the tree. Signs of the disease include small, pinhead-sized yellow or orange fruiting bodies exuding from the cankers. The fungus spreads by wind, birds, rain and insects.

Species Affected

The American chestnut is the primary tree infected and killed by chestnut blight. The fungus also infects, but does not kill, chinquapin and post oak.





Ecological Threat

The American chestnut was once the dominant hardwood species in our eastern forests, representing one-fourth of all trees. Its long-standing trees and snags served as wildlife shelters and its sweet nuts were eaten by humans, domesticated animals and wildlife.

Chestnut blight fungus virtually eliminated American chestnut trees from the eastern forests. The destruction of the American chestnut by chestnut blight has been labeled as one of the worst biological disasters in history, transforming the forests of eastern North America.

Management

Attempts to restore the American chestnut to eastern forests include development of resistant American chestnut hybrids, biological controls, and genetically engineered seedling stock. Share discoveries of wild American chestnuts producing nuts with The American Chestnut Foundation (www.acf.org) which tracks fruit-producing trees, utilizes these nuts in their research, and cooperates with their members for out-planting and testing cross-bred seedlings.

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Background: J.H. Ghent, USDA-FS, Bugwood.org; Bottom: L. Haugen, USDA-FS, Bugwood.org

Butternut Canker

Sirococcus clavigignenti-juglandacearum

Description

Butternut canker disease is of unknown origin, but its deadliness and rapid movement across butternut's range suggest it is an exotic species introduced to eastern North America.

Butternut canker disease is caused when the fungus infects a butternut tree through its buds, leaf scars, bark wounds, or natural bark cracks. Infections lead to sunken, elongated cankers that develop throughout the tree. Dieback of branches and twigs are symptoms of cankers girdling the stems. Cankers that occur on the main stem may eventually girdle the entire tree, resulting in tree death. The disease's fungal spores are spread by rain and possibly insects and birds. Nuts have been reported to be infected, and upon germination, seedlings may become infected and die.

Species Affected

Butternut canker most seriously impacts the butternut tree. Other walnut species are susceptible to infection but they usually do not die.

Photo credits:

Background: MN DNR Archive, Bugwood.org; Bottom, left to right: J. O'Brien, USDA-FS, Bugwood.org, M. Ostry, USDA-FS, Bugwood.org.

Ecological Threat

Butternut canker is an extremely virulent disease that threatens butternut throughout all of its range. It is estimated that as many as 80 percent of butternuts have been killed by this disease in several eastern states. The loss of butternut lowers forest diversity. Wildlife feed on its nuts, making this tree an important source of wildlife food, especially in the northern part of its range where the closely related black walnut does not grow.

Management

Currently, no methods exist to control this disease. Research is focused on finding and propagating disease resistant trees. The existence of uninfected mature butternuts in the vicinity of infected individuals suggests that genetic resistance may be present. Share discoveries of healthy butternuts in forest settings with the WV Department of Agriculture Plant Industries Division.



Thousand Cankers Disease

Geosmithia morbida (fungus)+
Pityophthorus juglandis (insect)

Description

Originally only killing western walnut species, western North America's thousand cankers disease crossed the continent in shipments of infected raw walnut wood. It has been transported to several states east of the Mississippi River since 2010, including Virginia and Pennsylvania.

Thousand cankers disease is caused by a fungus carried into walnut trees by the small walnut twig beetle—an insect which is native to the southwestern U.S. and Mexico. The fungus creates cankers in the inner bark that kill sections of the tree. Early symptoms of the disease are yellowing foliage that progresses rapidly to brown and wilted, dark amber stains on the bark surface, and tiny bark beetle holes. Overlapping dead areas of inner bark from numerous beetle entries and subsequent cankers eventually kill the walnut tree.



Species Affected

Thousand cankers disease primarily affects black walnut trees but other walnuts and butternut show varying degrees of susceptibility.

Ecological Threat

This disease threatens black walnut across its range. Black walnut is an important species for wildlife, especially squirrels and mice, because of its nutritious nut meat. Some wildlife species are expected to be moderately to severely affected if black walnut trees are lost due to the disease.

Management

There are no known means of reliably controlling the disease once it has infected a walnut. Attempts to control the walnut twig beetle with insecticides have not proven effective. Slowing the disease's spread into new black walnut populations is crucial to its management. Since the transport of infested raw wood is the most important pathway to new forests for thousand cankers disease, black walnut wood buyers can help slow the spread by choosing kiln-dried products for long distance shipments and using raw wood products locally.



Photo credits:

Background: N.Tisserat, Colorado St. Univ., Bugwood.org; Bottom, left to right: N.Tisserat, Colorado St. Univ., Bugwood.org, W. Cranshaw, Colorado St. Univ., Bugwood.org, S. Valley, OR Dept. Ag., Bugwood.org

Hemlock Woolly Adelgid

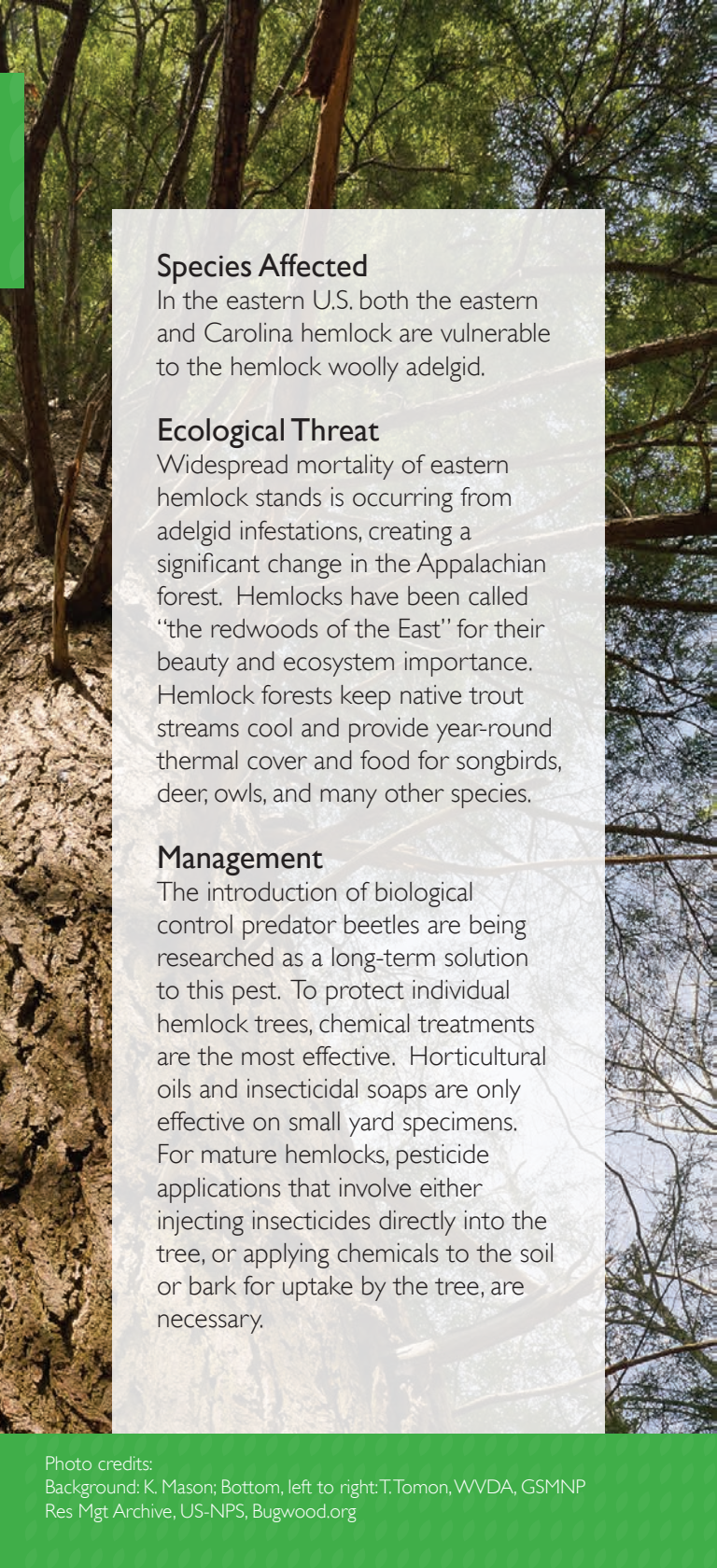
Adelges tsugae

Description

Hemlock woolly adelgids were discovered in eastern forests in 1951, near a Japanese-style garden in Richmond, VA. The Asian insect presumably was introduced on imported plants. Now occurring from Georgia to Maine, this pest was first detected in West Virginia in 1992.

The hemlock woolly adelgid is a tiny, aphid-like insect that feeds on tree sap at the base of hemlock needles. Adelgids cover themselves with a protective white, woolly material that makes them look like tiny “cotton balls” on the underside of the outer twigs. They are most noticeable from late fall to early summer. Symptoms of infestation include grayish-green needles that drop from the tree and a thinning crown that has lost its bright green color. Most infested trees die within three to five years.





Species Affected

In the eastern U.S. both the eastern and Carolina hemlock are vulnerable to the hemlock woolly adelgid.

Ecological Threat

Widespread mortality of eastern hemlock stands is occurring from adelgid infestations, creating a significant change in the Appalachian forest. Hemlocks have been called “the redwoods of the East” for their beauty and ecosystem importance. Hemlock forests keep native trout streams cool and provide year-round thermal cover and food for songbirds, deer, owls, and many other species.

Management

The introduction of biological control predator beetles are being researched as a long-term solution to this pest. To protect individual hemlock trees, chemical treatments are the most effective. Horticultural oils and insecticidal soaps are only effective on small yard specimens. For mature hemlocks, pesticide applications that involve either injecting insecticides directly into the tree, or applying chemicals to the soil or bark for uptake by the tree, are necessary.

Photo credits:

Background: K. Mason; Bottom, left to right: T.Tomon, WVDA, GSMNP
Res Mgt Archive, US-NPS, Bugwood.org

Emerald Ash Borer

Agrilus planipennis

Description

Emerald ash borer damage was first discovered near Detroit in 2002. The pest hitchhiked from Asia in solid wood crates or pallets used for packing products on cargo ships. It was detected in West Virginia in 2007.

The emerald ash borer is a very small, metallic green beetle about the size of a large grain of rice. Adults lay eggs in trees and the larvae feed and tunnel through the inner bark. This disrupts the flow of water and nutrients, eventually killing the tree. The larvae are flat, about an inch long, and white to cream colored. Distinct larval tunnels can easily be seen underneath the bark of infested ash trees. Woodpeckers remove the outer bark of infested ash trees in search of the larvae, creating a distinctive sign of infestation in the light patches on the tree trunks. Once mature, adult beetles leave the tree branches and trunks through D-shaped exit holes.



Species Affected

All major North American ash species — green, white, black and blue ash, as well as horticultural cultivars of these species—are killed by emerald ash borer.

Ecological Threat

Emerald ash borer is responsible for the death or decline of tens of millions of ash trees in a growing number of states. Ash is present in many forest types and habitats in the Appalachian Mountains, and its loss will likely lead to declines in the wildlife that depend on the species—from insects to small mammals. While most native borers kill only severely weakened trees, emerald ash borer kills healthy trees as well, making it especially devastating.

Management

Biological controls with parasitic insects and pesticide treatments for individual trees are the only options for managing emerald ash borer once it has infested a forest. Pesticide applications involve injecting insecticides directly into the tree. To slow the spread of this destructive pest, it is important to prevent new outbreaks by not moving firewood. Remember: Buy local, burn local.



Photo credits:

Background: T. Tomon, WVDA; Bottom, counter-clockwise: L. Bauer; USDA-FS N. Res. Stn, Bugwood.org, K.R. Law, USDA APHIS PPQ, Bugwood.org, D. Cappaert, MSU, Bugwood.org, E.R. Day, VPI&SU, Bugwood.org

Asian Longhorned Beetle

Anoplophora glabripennis

Description

Native to China and Korea, this serious pest entered the country at several ports in the mid-1990's. First detected in New York, Illinois, and Massachusetts, it has spread to multiple states primarily through the movement of infested wood. As of the summer 2012, the Asian longhorned beetle had not been detected in West Virginia though it is in nearby Ohio.

The Asian longhorned beetle is a glossy black beetle, $\frac{3}{4}$ to $1\frac{1}{4}$ inches long, with mottled white spots on its back and long antennae with distinctive black and white bands on each segment. The feet have a bluish hue. The larvae are large, round, and are white to cream colored. They burrow deep beneath tree bark where they live for 1-2 years, girdling the tree trunk and branches, causing dieback of the tree crown and eventual death of the tree. When mature, the adult beetles emerge making large round exit holes on tree branches or trunks.



Species Affected

The Asian longhorned beetle will attack many different species of hardwood trees: All species of maples, birch, ash, poplars, willows, horsechestnut, and American elm are hosts.

Ecological Threat

This pest has the potential to significantly impact forest composition and the supply of maple syrup. It is a serious threat because of its broad range of hosts and appetite for both stressed and healthy trees.

Management

At this time the only effective means of dealing with trees infested with Asian longhorned beetle is to cut them down, chip and burn all of the wood, and grind the stump. Trees that are susceptible, but not yet infested, may be protected with a pesticide treatment. To slow the spread of this destructive pest, it is important to prevent new outbreaks by not moving infested wood.



Photo credits:

Background: D. Haugen, USDA-FS, Bugwood.org; Bottom, left to right: T. Tomon, WVDA, T.B. Denholm, NJ Dept. Agric., Bugwood.org, S. Valley, Oregon Dept. Agric., Bugwood.org, K.R. Law, USDA APHIS PPQ, Bugwood.org.

European Woodwasp

Sirex noctilio

Description

Native to Europe, Asia, and northern Africa, European woodwasps were accidentally introduced to New York state forests in 2004, when they escaped from imported solid wood packing materials. As of the summer of 2012, European woodwasp had not been detected in West Virginia.

Adult European woodwasps are dark, metallic blue/black insects that are 1-1 ½ inches long. Legs are reddish-yellow, feet are black, and antennae are entirely black. Female *Sirex* inject a fungus, a toxic mucus, and their eggs into the bark of pine trees. The fungus and mucus act to kill the tree and create a suitable environment for the larvae to develop. The larvae are creamy white and have a dark spine at the rear of the abdomen. Symptoms of infestation are beads of resin dribbling from egg-laying sites and red crowns.





Species Affected

All pine species are believed to be at risk of infestation from European woodwasp. Unlike native *Sirex*, European woodwasps attack living pines as well as stressed and dying trees.

Ecological Threat

Pines add important conifer diversity to the Central Appalachian's hardwood-dominated forests, providing pine nuts, forage and cover to wildlife. European woodwasp infestations could damage the pine component of these forests, and lead to the loss of unique ridgetop pine communities.

Management

Biological controls exist for European woodwasp, and populations have been successfully managed using a parasitic nematode as a biological control agent. The nematodes effectively regulate the *Sirex* populations below damaging levels. European woodwasp infestations have a high potential to spread through movement of raw wood and firewood. Care must be taken to not move infested wood into new areas.

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Background: D. Haugen, Bugwood.org; Bottom, left to right: V. Klasmer; Inst. Nac. De Tec. Agropecuaria, Bugwood.org, D. Haugen, Bugwood.org

Gypsy Moth

Lymantria dispar

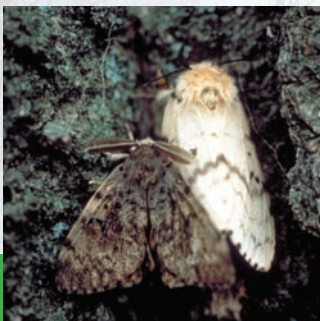
Description

The gypsy moth is native to Europe and Asia and was imported to Massachusetts in the mid-1800's as a silk moth. It escaped and has spread south. Gypsy moth was first discovered in West Virginia in 1972.

Gypsy moth caterpillars have five pairs of blue dots followed by six pairs of red dots on their backs. They feed on the leaves of preferred trees and shrubs, and trees may be partially or entirely defoliated. Adult moths are brown with 1 to 2 inch wingspans, dark diagonal wing patterns, and large feathered antennas. Females lay nickel-sized, brownish hairy egg masses on trees and many other surfaces.

Species Affected

In the eastern U.S. gypsy moth caterpillars prefer oaks, apple, sweetgum, speckled alder, basswood, gray and white birch, poplar, willow, and hawthorn, although other species are also affected. Forests comprised of over 50% oaks are especially susceptible to defoliation. The most susceptible forests are concentrated in the southern Appalachian Mountains, Ozark Mountains, and throughout the Lake States.



Ecological Threat

The gypsy moth is one of the most damaging defoliators in the U.S. In serious outbreaks more than 50% of the oaks and other highly favored hardwood trees may die, causing massive shifts in forest composition. This leads to significant losses of food sources for turkeys, deer, squirrels, and other species.

Management

Silvicultural treatments improve a forest's chances of surviving a gypsy moth infestation. In oak stands where severe impacts are likely, the aerial spraying of insecticides to kill gypsy moth caterpillars may prevent heavy defoliation. Habitats of rare butterflies should be avoided when using this treatment. During severe outbreaks, when caterpillar food sources get low, an effective, naturally-occurring control involves the combination of a gypsy moth virus (NPV) and a fungus *Entomophaga maimaiga*.

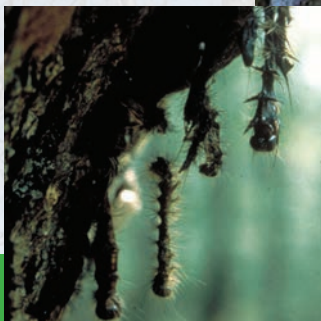


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Background: F. Lakatos, U. West-Hungary, Bugwood.org; Bottom, left to right: E. Akulov, Russian Rsrch Inst. Plant Quarantine, Bugwood.org, J.H. Ghent, USDA-FS, Bugwood.org, K.H. Knauer, USDA-FS, Bugwood.org, J.H. Ghent, USDA-FS, Bugwood.org

Dogwood Anthracnose

Discula destructiva

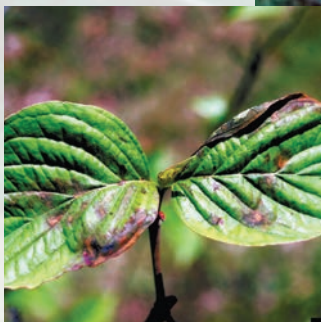
Description

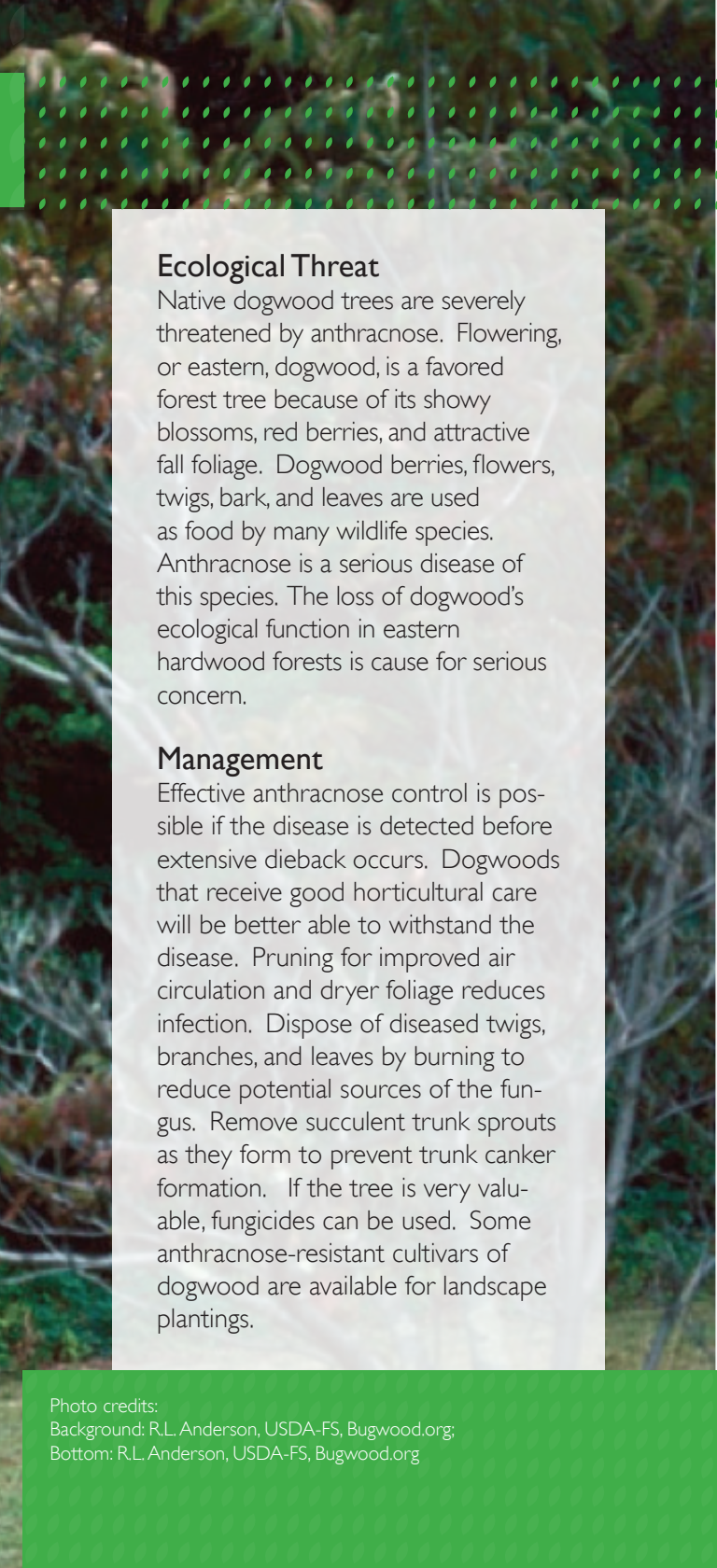
Dogwood anthracnose disease was first reported in New York and Connecticut in 1978. During the last 25-30 years it has moved down the Appalachian Mountains into many southern states.

Dogwood anthracnose is caused by the fungus *Discula destructiva*. The fungus infects the leaves, causing medium-large, purple-bordered leaf spots and scorched tan blotches that may enlarge to kill the entire leaf. When the whole leaf becomes infected, the fungus grows into the petiole and then into the twig, where it causes a canker. If left unchecked, these cankers increase in size and eventually girdle and kill twigs, branches, or the main trunk.

Species Affected

Dogwood anthracnose affects only eastern dogwood (*Cornus florida*) and Pacific dogwood (*Cornus nuttallii*).





Ecological Threat

Native dogwood trees are severely threatened by anthracnose. Flowering, or eastern, dogwood, is a favored forest tree because of its showy blossoms, red berries, and attractive fall foliage. Dogwood berries, flowers, twigs, bark, and leaves are used as food by many wildlife species. Anthracnose is a serious disease of this species. The loss of dogwood's ecological function in eastern hardwood forests is cause for serious concern.

Management

Effective anthracnose control is possible if the disease is detected before extensive dieback occurs. Dogwoods that receive good horticultural care will be better able to withstand the disease. Pruning for improved air circulation and dryer foliage reduces infection. Dispose of diseased twigs, branches, and leaves by burning to reduce potential sources of the fungus. Remove succulent trunk sprouts as they form to prevent trunk canker formation. If the tree is very valuable, fungicides can be used. Some anthracnose-resistant cultivars of dogwood are available for landscape plantings.

Photo credits:

Background: R.L. Anderson, USDA-FS, Bugwood.org;

Bottom: R.L. Anderson, USDA-FS, Bugwood.org

What You Can Do

Learn to identify invasive pests and pathogens at www.bugwood.org and report new infestations at www.hungrypests.com.

Participate with local cooperative invasive species programs such as the Potomac Highlands CWPMA - www.phcwpma.org.

Investigate changes in your forest's health with the assistance of entomologists, foresters, and pathologists. Find help at the following:

- WVDA Plant Industries Division
- WV Division of Forestry
- WVU Extension Service

Practice excellent forestry through the development and implementation of a long-term forest management plan. Find a forester through the WV Division of Forestry Landowner Assistance program.

Evaluate the benefits and risks of all control methods, including indirect environmental and wildlife impacts. Select an effective method that will cause the least harm to the environment. Carry out treatments with the input of a professional, keep records, and monitor results.

Useful websites to find assistance:

www.wvagriculture.org/images/Plant_Industries/About_Us.html

www.wvforestry.org

www.anr.ext.wvu.edu/pests

Collect or buy firewood within a 50-mile radius of where you plan to burn it. If that isn't possible, buy firewood that is certified as heat treated or kiln-dried to kill embedded insects and diseases. Leave unused campfire wood behind when you go home.

Dispose of wooden packing material through burning or landfilling.

Choose kiln-dried lumber for long distance wood shipments whenever possible. When shipping raw wood and lumber, insure the material is not transporting invasive species.

Be aware of quarantines by the WVDA Plant Industries Division and USDA APHIS before shipping across county and state borders.

Check and clean gear, tools, vehicles, tires, and harvesting equipment of mud, weeds, wood scraps, and insects when moving between jobs to guard against carrying invasive species to new forests.

Buy locally-produced wood and plant products.



Funding provided by:
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